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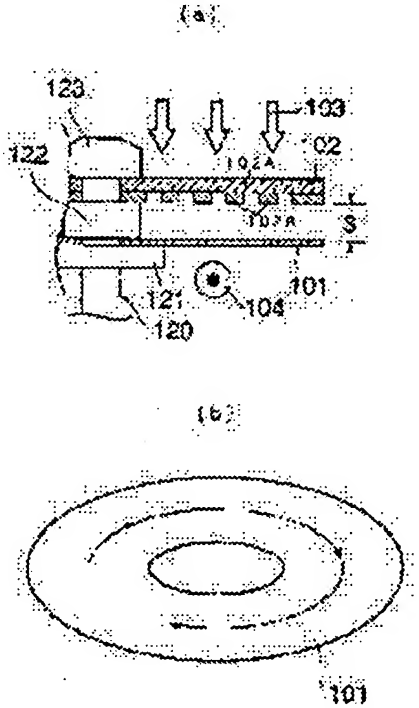
(54) MAGNETIZATION PATTERN FORMING METHOD FOR MAGNETIC RECORDING MEDIUM, MAGNETIC RECORDING MEDIUM AND MAGNETIC RECORDING DEVICE AS WELL AS PHOTOMASK

(57)Abstract:

PROBLEM TO BE SOLVED: To rapidly and inexpensively provide a magnetic recording medium and a magnetic recording device which are less affected by interference fringes, are high in the accuracy of magnetization patterns and small in the modulation of the output signal of the magnetization patterns and permit high-density recording.

SOLUTION: This magnetization pattern forming method for the magnetic recording medium includes a process step of locally heating the irradiated portions of a magnetic layer by irradiating the magnetic recording medium 101 having the magnetic layer on a substrate with energy rays through a photomask 102 provided with the transparent potion and non-transparent portions of the energy rays and a process step of impressing external magnetic fields to the magnetic layer. The film thickness d of the non-transparent layer 102B of the energy rays formed on the transparent substrate 102A of the photomask 102 is $(m\times\lambda/4)-10\ nm\leq d\leq(m\times\lambda/4)+10\ nm$ (m is an odd natural number, λ is the wavelength of the energy rays in the air).



CLAIMS

[Claim(s)]
[Claim 1] By forming the nontransparent layer of an energy line on a transparence base material to the magnetic-recording medium which comes to have a magnetic layer on a substrate The process which irradiates an energy line through the photo mask with which the transparency section and the nontransparent section of an energy line were prepared, and heats the irradiated section of this magnetic layer locally, It is the magnetization pattern formation approach of a magnetic-recording medium including the process which impresses an external magnetic field to this magnetic layer. The thickness d of the nontransparent layer of the energy line formed on the transparence base material of this photo mask The magnetization pattern formation approach of the magnetic-recording medium characterized by filling (mxlambda/4)-10 nm<=d<=(mxlambda/4)+10nm (however, m taking as the odd natural numbers and lambda being taken as the wavelength in the inside of the air of an energy line).
[Claim 2] The magnetization pattern formation approach of a magnetic-recording medium according to claim 1 that m is 1, 3, or 5.
[Claim 3] The magnetization pattern formation approach of a magnetic-recording medium according to claim 1 or 2 that the reflection factor difference of the transparency section of said photo mask and the nontransparent section is less than 20%.
[Claim 4] The magnetization pattern formation approach of a magnetic-recording medium given in claim 1 thru/or any 1 term of 3 which the nontransparent layer of said photo mask becomes from a cascade screen with a wrap chrome oxide layer about a chromium layer and this chromium layer.
[Claim 5] The magnetization pattern formation approach of a magnetic-recording medium given in claim 1 thru/or any 1 term of 4 which consists of ingredients with which the base material of said photo mask is mainly concerned with a quartz.
[Claim 6] The magnetization pattern formation approach of a magnetic-recording medium given in claim 1 thru/or any 1 term of 5 by which the distance between these magnetic-recording media maintains a gap 1mm or less, and this photo mask is arranged in the case of magnetization pattern formation.
[Claim 7] The magnetic-recording medium characterized by coming to form a magnetization pattern in claim 1 thru/or any 1 term of 6 by the magnetization pattern formation approach of the magnetic-recording medium a publication.
[Claim 8] A magnetic-recording medium, the mechanical component which drives a magnetic-recording medium in the record direction, and the magnetic head which consists of the Records Department and the playback section, It is the magnetic recording medium which has a means to make the magnetic head displaced relatively to a magnetic-recording medium, and a record regenerative-signal processing means for performing the record signal input to the magnetic head, and the regenerative-signal output from the magnetic head. The magnetic recording medium characterized by a magnetic-recording medium being a magnetic-recording medium which comes to form a magnetization pattern in claim 1 thru/or any 1 term of 6 by the magnetization pattern formation approach of the magnetic-recording medium a publication.
[Claim 9] The magnetic recording medium according to claim 8 which reproduces said magnetization pattern by the magnetic head, acquires a signal, and comes to record a servo burst signal by this magnetic head on the basis of this signal after building a magnetic-recording medium into equipment.
[Claim 10] By forming the nontransparent layer of an energy line on a transparence base material to the magnetic-recording medium which comes to have a magnetic layer on a substrate An energy line is irradiated through the photo mask with which the transparency section and the nontransparent section of an energy line were prepared. It is the photo mask used for the magnetization pattern formation approach of a magnetic-recording medium including the process which heats the irradiated section of this magnetic layer locally, and the process which impresses an external magnetic field to this magnetic layer. The photo mask characterized by the thickness d of the nontransparent layer of the energy line formed on this transparence base material filling (mxlambda/4)-10 nm<=d<=(mxlambda/4)+10nm (however, m taking as the odd natural numbers and lambda being taken as the wavelength in the inside of the air of an energy line).
[Claim 11] The photo mask according to claim 10 whose m is 1, 3, or 5.
[Claim 12] The photo mask according to claim 10 or 11 whose reflection factor difference of said transparency section and nontransparent section is less than 20%.
[Claim 13] A photo mask given in claim 10 thru/or any 1 term of 12 which said nontransparent layer becomes from a cascade screen with a wrap chrome oxide layer about a chromium layer and this chromium layer.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the photo mask used for the magnetization pattern formation approach of magnetic-recording media, such as a magnetic disk used for a magnetic recording medium, and it. This invention relates to the magnetic-recording medium and magnetic recording medium which were created using this photo mask again.
[0002]
[A Prior art and advanced technology] The magnetic recording medium represented by the magnetic disk drive (hard disk drive) is widely used as external storage of information processors, such as a computer, and is being used in recent years also as the image transcription equipment of a dynamic image, or a recording device for a set top box.
[0003] A magnetic disk drive usually consists of the shaft which fixes one sheet or two or more sheets for a magnetic disk in the shape of food on a skewer, the motor made to rotate the magnetic disk joined to this shaft through bearing, the magnetic head used for record and/or playback, an arm in which this head was attached, and an actuator which can be made to move a head to the location of the arbitration on a magnetic-recording medium through a head arm.
[0004] The magnetic head for record playback is usually a surfacing mold head, and is moving by the fixed flying height in the magnetic-disk top. Moreover, since the distance with a magnetic disk other than a surfacing mold head is contracted more, use of a contact head (contact mold head) is also proposed.
[0005] After the magnetic-recording medium (magnetic disk) carried in a magnetic disk drive forms a NiP layer in the front face of the substrate which generally consists of an aluminium alloy etc. and performs necessary data smoothing, texture ring processing, etc., on it, it carries out sequential formation of the bottom stratum of a metal, a magnetic layer (information recording layer), a protective layer, the lubricating layer, etc., and is produced. Or sequential formation of the bottom stratum of a metal, a magnetic layer (information recording layer), a protective layer, the lubricating layer, etc. is carried out, and it is produced by the front face of the substrate which consists of glass etc.
[0006] There are a magnetic-recording medium within a field and a vertical-magnetic-recording medium as magnetic-recording medium, and, as for the magnetic-recording medium within a field, longitudinal record is usually performed.
[0007] The densification of a magnetic-recording medium is gathering the rate every year, and there are various things in the technique of realizing this. For example, make the flying height of the magnetic head smaller, a GMR head is adopted as the magnetic head, and amelioration of making [of coercive force] high the magnetic material used for the recording layer of a magnetic disk, to narrow spacing of the information recording track of a magnetic disk, etc. are tried. For example, in order to realize 2 100 Gbit/inch, as for track density, 100 or more ktpis are needed.
[0008] The magnetization pattern for control for controlling the magnetic head, for example, the signal used for the position control of the magnetic head, and the signal used for a synchronousr control are formed in each truck. If spacing of an information recording track is narrowed and the number of trucks is made to increase for densification, the signal (it may be hereafter called a "servo signal") used for the position control of data logging / head for playback is also established densely, i.e., more mostly, to radial [of a disk] according to it, and it must enable it to perform precise control.
[0009] On the other hand, the gap section between the field used in addition to data logging, i.e., the field used for a servo signal, this servo field, and a data storage area is made small, a data storage area is made large, and it is also necessary for densification to raise data-logging capacity. It is necessary for that to raise the output of a servo signal, or to raise the precision of a synchronizing signal.
[0010] Conventionally, the approach widely used for manufacture of a magnetic-recording medium makes a hole near the head actuator of a drive (magnetic recording medium), inserts a pin with an encoder in the part, is engaged in an actuator by this pin, drives a head in an exact location, and records a servo signal. However, since it was in the location where the centers of gravity of a positioning device and an actuator differ by this approach, it was difficult to be unable to perform highly precise truck position control, but to record a servo signal correctly.
[0011] The technique which forms a concavo-convex servo signal is also proposed by irradiating a laser beam at a magnetic disk, making a disk front face deform locally on the other hand, and forming physical irregularity. However, in order to form every one; irregularity which a surfacing head needs to become unstable with the irregularity on the front face of a disk, needs to use a laser beam with power big in order to form; irregularity which has a bad influence on record playback by this approach, and requires cost, there was the problem; which requires time amount.
[0012] For this reason, recently, the method of forming a new servo signal is proposed.
[0013] An example is the approach of applying an auxiliary field from the exterior and imprinting a magnetization pattern while it forms a servo pattern in a master disc with the magnetic layer of high coercive force and makes a magnetic-recording medium stick a master disc to it (USP No. 5,991,104).
[0014] They are approaches to which an external magnetic field is applied while other examples magnetize the medium to the one direction beforehand, carry out patterning of the soft magnetism layer of the low coercive force in high permeability to a master disc and making them stick it through a master disc. By this approach, a soft magnetism layer works as shielding and a magnetization pattern is imprinted by the field which is not shielded (JP,50-60212,A (USP No. 3,869,711), JP,10-40544,A (EP No. 915456), Digest of InterMag

2000, GT-06, reference). With this technique, it forms through a magnetization pattern by the powerful field using a master disc.
[0015] Generally, since it depends for the reinforcement of a field on distance, in case a magnetization pattern is recorded by the field, a pattern boundary tends to become not clear by the leakage field. Then, in order to make a leakage field into min, it is indispensable to stick a master disc and a magnetic-recording medium. And it is necessary to make it stick completely without a clearance, and both are usually stuck by vacuum adsorption etc. by pressure, so that a pattern becomes detailed. Moreover, since the field used for an imprint also becomes large and a leakage field also becomes large so that the coercive force of a medium becomes high, it is necessary to make it stick still more completely.
[0016] Therefore, although it is easy to apply the above-mentioned technique to the low magnetic disk and the flexible floppy (trademark) disk which is easy to stick by pressure of coercive force, application to a magnetic disk using a hard substrate which has 3000 or more Oes of coercive force for high density record is very difficult for it. That is, the defect arose or the magnetic disk of a hard substrate had a possibility that minute dust etc. might be put in the case of adhesion with a master disc, and a medium might hurt an expensive master disc at it. when a glass substrate was used especially, dust put, it came out and there was a problem that adhesion becomes inadequate, and could not carry out magnetic transfer or a crack occurred to a magnetic-recording medium.
[0017] Moreover, with a technique which was indicated by JP,50-60212,A, to the direction of a truck of a disk, although the pattern with a slanting include angle was recordable, there was a problem that only a pattern with weak signal strength could be made. That is, in order that coercive force may secure the magnetic field strength of an imprint to the magnetic-recording medium of high coercive force of 2000-2500 or more Oes, the large soft magnetic material of saturation magnetic flux density, such as a permalloy or Sendust, must be used for the ferromagnetic for patterns of a master disc (shielding material). However, by the slanting pattern, the field of flux reversal cannot become the gap which the ferromagnetic layer of a master disc makes perpendicularly, and cannot lean magnetization towards desired. Consequently, a part of field escapes in a ferromagnetic layer, sufficient field for the part of a request in the case of magnetic transfer cannot start easily, and enough flux reversal patterns cannot be formed, but it will be hard coming to obtain high signal strength. The playback output of such a slanting magnetization pattern will decrease to a pattern perpendicular to a truck more greatly than an azimuth loss.
[0018] On the other hand, the technique which forms a magnetization pattern in a magnetic-recording medium combining partial heating and external magnetic field impression is indicated by the application for patent No. 134608 [2000 to], and the application-for-patent No. 134611 [2000 to] specification. For example, the medium is beforehand magnetized to the one direction, an energy line etc. is irradiated through the photo mask by which patterning was carried out, and it heats locally, an external magnetic field is impressed, lowering the coercive force of this heating field, record by the external magnetic field is performed to a heating field, and a magnetization pattern is formed in it.
[0019] Since according to this technique coercive force is lowered with heating and an external magnetic field is impressed, an external magnetic field does not need to be higher than the coercive force of a medium, and can record by the weak field. And since it is not recorded even if the field recorded is limited to a heating field and a field is impressed in addition to a heating field, even if it does not stick a mask etc. to a medium, a clear magnetization pattern is recordable. For this reason, the defect of a medium is not made to increase, without damaging a medium and a mask by sticking by pressure.
[0020] Moreover, with this technique, since it is not necessary to shield an external magnetic field with the soft magnetic material of a master disc like before, a slanting magnetization pattern can also be formed good.
[0021] That what is necessary is just a mask equipped with the transparency section equivalent to a desired magnetization pattern, and the nontransparent section, the photo mask used for this magnetization pattern formation approach can carry out sputtering formation of the metals, such as Cr, on transparence original recording, such as quartz glass and soda lime glass, can apply a photoresist on it, and can create the desired transparency section and the desired nontransparent section by etching etc. In this case, the parts of only the energy-line nontransparent section and original recording serve as [the part which has Cr layer on original recording] the transparency section.
[0022]
[Problem(s) to be Solved by the Invention] Thus, the magnetization pattern formation technique indicated by the application for patent No. 134608 [2000 to], and the application-for-patent No. 134611 [2000 to] specification Although it is the outstanding technique to which the defect of a medium is not made to increase, without being able to form various kinds of detailed magnetization patterns with an efficiently and sufficient precision, and moreover damaging a magnetic-recording medium and a mask In this technique, when using a photo mask for the following reason, the interference fringe might be formed in the pattern side, and it had become the cause by which this reduced the precision of a magnetization pattern.
[0023] That is, a part is reflected although most will be absorbed for the light which penetrated the photo mask once by the magnetic-recording medium side in a magnetic-recording medium. Again, in a mask side, the part is reflected in respect of a mask, and the reflected light forms an interference fringe. If an interference fringe is formed, the shade pattern of an energy line which is different from a mask pattern in an energy line will be formed, and the modulation of the output signal of a magnetization pattern will get worse.
[0024] Then, this invention solves such a problem, offers the photo mask used for the magnetization pattern formation approach of a magnetic-recording medium and it which can form a detailed magnetization pattern with an efficient still more sufficient precision in the technique which forms a magnetization pattern in a magnetic-recording medium combining partial heating and external magnetic field impression, and aims the magnetic-recording medium and the magnetic recording medium in which thereby more much more high-density record is possible at a short time and providing cheaply.
[0025]
[Means for Solving the Problem] The magnetization pattern formation approach of the magnetic-recording medium of this invention By forming the nontransparent layer of an energy line on a transparence base material to the magnetic-recording medium which comes to have a magnetic layer on a substrate The photo mask with which the transparency section and the nontransparent section of an energy line were prepared is minded. The process which irradiates an energy line and heats the irradiated section of this magnetic layer locally, It is the magnetization pattern formation approach of a magnetic-recording medium including the process which impresses an external magnetic field to this magnetic layer. It is characterized by the thickness d of the nontransparent layer of the energy line formed on the transparence base material of this photo mask filling (mxlambda/4)-10 nm<=d<=(mxlambda/4)+10nm (however, m taking as the odd natural numbers and lambda being taken as the wavelength in the inside of the air of an energy line).
[0026] The photo mask of this invention by forming the nontransparent layer of an energy line on a transparence base material to the magnetic-recording medium which comes to have a magnetic layer on a substrate The process which irradiates an energy line through the

photo mask with which the transparency section and the nontransparent section of an energy line were prepared, and heats the irradiated section of this magnetic layer locally, It is the photo mask used for the magnetization pattern formation approach of a magnetic-recording medium including the process which impresses an external magnetic field to a magnetic layer. It is characterized by the thickness d of the nontransparent layer of the energy line formed on the transparence base material filling (mxlambda/4)-10 nm<=d<=(mxlambda/4)+10nm (however, m taking as the odd natural numbers and lambda being taken as the wavelength in the inside of the air of an energy line).
[0027] Since partial heating and external magnetic field impression are combined [according to this magnetization pattern formation approach] in forming a magnetization pattern, it is not necessary to use a strong external magnetic field like before. And since it is not magnetized even if a field is impressed in addition to a heating field, magnetic-domain formation can be limited to a heating field. For this reason, magnetization transition width of face is small, magnetization transition on the boundary of a magnetic domain is very steep, a pattern with the high quality of an output signal can be formed [a magnetic-domain boundary becomes clear,], and it is also possible by choosing conditions to set magnetization transition width of face to 1 micrometer or less.
[0028] And without damaging a medium and a mask, since it is not necessary to make a magnetic-recording medium and a master disc stick by pressure like before, there is also no possibility of making the defect of a medium increasing, and a slanting magnetization pattern can also be formed good to a truck.
[0029] Moreover, since an energy line is used for partial heating, it is easy to carry out the magnitude of a part and the control of power to heat, and a magnetization pattern can be formed with a sufficient precision.
[0030] Moreover, once it produces this photo mask, the magnetization pattern of any configurations and the special pattern which was hard to make from a complicated pattern and a complicated conventional method since it formed on a medium can be formed easily.
[0031] For example, the magnetization pattern aslant prolonged from inner circumference linearly to a radius and a truck at a periphery is used for the phase servo system of a magnetic disk. By the conventional servo pattern formation approach which records one truck of servo signals at a time, it was hard to form a slanting pattern in such a pattern and a radius that followed radial, rotating a disk. According to this invention, neither complicated count nor a complicated equipment configuration is needed, but such a magnetization pattern can be once formed in simple and a short time by exposure.
[0032] Since it can be used that what is necessary is just magnitude including the repeat unit of a magnetization pattern, being able to move it even if it is not a wrap thing about the whole magnetic-disk surface, this photo mask can be created simple and cheaply.
[0033] Moreover, if the magnetization pattern for a part for a multiple track and two or more sectors is put in block a major diameter or horizontally and the beam diameter of an energy line is irradiated as a long and slender ellipse form etc., it goes up much more, the problem that servo write-in time amount increases in connection with the elongation of a future capacity is also solved, and write-in effectiveness is very desirable.
[0034] Be [what is necessary / just although a photo mask forms the shade (intensity distribution) of an energy line on a magnetic-disk side corresponding to the magnetization pattern which should be formed], its photo mask which has the transparency section which penetrates an energy line according to a pattern is desirable at the point which can be created simply and cheaply.
[0035] And in this invention, thickness d of the nontransparent layer of a photo mask is set to (mxlambda/4)-10 nm<=d<=(mxlambda/4) +10nm (however, m takes as the odd natural numbers and lambda is taken as the wavelength in the inside of the air of an energy line).
[0036] Since the reflection in respect of transparency of a photo mask and the reflection in respect of nontransparent serve as an opposite phase and these negate each other by forming the nontransparent layer of a photo mask by such thickness, the effect of reflective is mitigated, generation of an interference fringe is suppressed, and formation of an accurate magnetization pattern is attained.
[0037] Although it is most desirable to form in the thickness of d= (mxlambda/4) as for a nontransparent layer, even if there is a gap of about **10nm, the effectiveness of this invention is acquired.
[0038] That is, a part is reflected although most will be absorbed for the energy line which carried out incidence through the photo mask like the above-mentioned by the magnetic-recording medium side in a magnetic-recording medium. And it becomes "the energy line reflected between the transparency sections of a medium side and a mask side", and "the energy line reflected between the nontransparent sections of a medium side and a mask side." In addition, as an energy line, the laser to which the phase was equal is usually used.
[0039] Originally, since laser is expensive, if rectilinear-propagation nature is carrying out incidence at right angles to a photo mask, there will be "no energy line reflected between the nontransparent sections of a medium side and a mask side" theoretically. However, since laser is extracted with an objective lens and incidence is carried out to a mask, incidence is usually carried out aslant in many cases. For this reason, "the energy line reflected between the nontransparent sections of a medium side and a mask side" exists.
[0040] "According to this invention, thickness d of the nontransparent layer of a photo mask is set to (mxlambda/4)-10 nm<=d<= (mxlambda/4)+10nm. A medium side, With the energy line reflected between the transparency sections of a mask side", and "the energy line reflected between the nontransparent sections of a medium side and a mask side", lambda/4 of the optical path difference of 2 twice (gone part) =lambda/2 will occur, and it will shift half wave length exactly. By shifting half wave length, since a phase becomes reverse, it denies, and both suit, they weaken and suit. By this, the effect of reflective is mitigated, generation of an interference fringe is suppressed, and accurate magnetization pattern formation can be performed.
[0041] In order to mitigate the effect of an interference fringe, it was effective to have raised to the power to which a magnetic-recording medium side does not damage energy power, to also have raised a field to extent which does not influence in the direction of the magnetic domain in a room temperature, and to have formed a magnetization pattern, but even if it adopted such conditions, it was difficult to remove the effect of an interference fringe completely. Moreover, since the reinforcement of an interference fringe changed with own waves of a magnetic-recording medium etc. at the time of production, it was difficult to set up the power suitable for all the production article, and a field. On the other hand, according to this invention, generation of an interference fringe can be suppressed, without changing a magnetization pattern formation process a lot.
[0042] As for m in the formula of said thickness, in this invention, it is desirable that it is 1, 3, or 5. That is, even if it makes m large to **, in respect of the effectiveness of interference, it is equivalent. Although the thickness from which sufficient nontransparent ability is obtained by the quality of the material and the precision of a nontransparent layer differs, the smaller one of m is good in the range in which sufficient nontransparent ability is obtained from the point of a manufacturing cost or production time. However, since there is possibility (it will be transparent) that sufficient nontransparent nature will not be obtained depending on the quality of the material of a nontransparent layer when thickness is too thin, especially m= 3 is desirable.
[0043] Moreover, as for the reflection factor difference of the transparency section of a photo mask, and the nontransparent section, it is desirable that it is less than 20%. That is, in order to enlarge effectiveness which the reflected lights of the transparency section and the

nontransparent section are made to interfere, and is negated, the difference of the reflection factor of the transparency section and the nontransparent section is small, and a comparable thing is desirable.
[0044] Moreover, as for the base material of a photo mask, it is desirable to consist of ingredients which are mainly concerned with a quartz, and, as for the nontransparent layer of a photo mask, it is desirable that it is a cascade screen with a wrap chrome oxide layer about a chromium layer and this chromium layer. That is, since the permeability of a quartz of the energy line of an ultraviolet region is high, it has the advantage that an energy line with a short wavelength of 300nm or less which especially micro processing tends to carry out can be used. And since the reflection factor is very high at one side, that [chromium's] of a wrap is desirable [the reflection factor of the transparency section is about 5% in general in quartz glass etc., and] at chrome oxide of about 18% of reflection factors in the front face.
[0045] As for a photo mask, it is desirable in the case of the magnetization pattern formation by this invention that the distance between magnetic-recording media maintains a gap 1mm or less, and is arranged. If this distance is larger than 1mm, the diffraction of an energy line is large, and a magnetization pattern tends to fade and it is not desirable.
[0046] The magnetic-recording medium of this invention forms a magnetization pattern according to this invention approach using the photo mask of such this invention, there is little effect of an interference fringe, the precision of a magnetization pattern is high and the modulation of the output signal of a magnetization pattern serves as a small good magnetic-recording medium. In case especially a servo pattern is formed, since the magnitude of modulation influences positioning accuracy greatly, effectiveness is large. The maximum and the minimum value in TAA (total average amplitude) and its field are expressed in Mod=(AMPmax-AMPmin)/TAAx100 as the modulation (Mod) at this time in it, when the average output of the same pattern space is set to AMPmax and AMPmin, respectively. However, TAA, AMPmax, and AMPmin are the values of a peak to peak. The value of modulation considers servo-tracking precision and is 10% or less still more preferably 25% or less preferably.
[0047] The mechanical component to which the magnetic recording medium of this invention drives a magnetic-recording medium and a magnetic-recording medium in the record direction, The magnetic head which consists of the Records Department and the playback section, and a means to make the magnetic head displaced relatively to a magnetic-recording medium, It is the magnetic recording medium which has a record regenerative-signal processing means for performing the record signal input to the magnetic head, and the regenerative-signal output from the magnetic head. As a magnetic-recording medium The magnetic-recording medium in which it comes to form a magnetization pattern by the magnetization pattern formation approach of this invention using the photo mask of such this invention is used. Since the magnetic-recording medium by which magnetization patterns, such as a highly precise servo pattern, were formed is used, high density record is possible, and there is no blemish in a medium, and since there are also few defects, little record of an error can be performed.
[0048] If it is this magnetic recording medium, after building a magnetic-recording medium into equipment, a magnetization pattern can be reproduced by the magnetic head, a signal can be acquired, and a servo burst signal can be recorded by the magnetic head on the basis of this signal.
[0049]
[Embodiment of the Invention] With reference to a drawing, the gestalt of operation of this invention is explained below.
[0050] First, with reference to drawing 1 , the magnetization pattern formation approach using the photo mask of this invention is explained. Drawing 1 R> 1 (a) is the typical sectional view showing the gestalt of the operation of the magnetization pattern formation approach which used the photo mask of this invention, and drawing 1 (b) is the typical perspective view showing the magnetization direction of a magnetic disk.
[0051] First, the magnetic-recording medium (magnetic disk) 101 is beforehand magnetized uniformly to the one direction of a hoop direction by the external magnetic field (drawing 1 (b)). Then, the magnetic-recording medium 101 is attached in a spindle 120 (drawing 1 (a)). That is, it allots on a turntable 121 and a photo mask 102 is attached through a spacer 122, and further, the presser-foot plate 123 is carried and it fixes by the rivet which is not illustrated. Between the magnetic-recording medium 101 and a photo mask 102, the tooth space S by the spacer 122 is formed. An external magnetic field 104 is impressed at the same time it irradiates the pulse-like laser beam 103 in this condition. The external magnetic field at the time of magnetizing this external magnetic field uniformly to the magnetic-recording medium 101 previously is hard flow.
[0052] On the occasion of formation of a magnetization pattern, the photo mask 102 which formed two or more transparency sections (transparence base material 102A) and nontransparent section 102B according to the magnetization pattern which should be formed is prepared, and a laser beam 103 is irradiated on the magnetic layer of the magnetic-recording medium 101 through this. If the magnetization pattern for a part for a multiple track and two or more sectors is put in block a major diameter or horizontally and a beam diameter is irradiated as a long and slender ellipse form etc. in this exposure, it goes up much more, the problem that servo chart lasting time increases in connection with the elongation of a future capacity is also solved, and recording efficiency is very desirable.
[0053] In this invention, that with which it comes to form nontransparent layer 102B of the energy line formed on transparence base material 102A as a photo mask 102, and the thickness d of this nontransparent layer 102B fills (mxlambda/4)-10 nm<=d<=(mxlambda/4) +10nm (however, m takes as the odd natural numbers and lambda is taken as the wavelength in the inside of the air of an energy line) is used in such a magnetization pattern formation approach.
[0054] Among the above-mentioned formula, if m is the odd natural numbers, it is good without limit, but when using it by 3 or about 5 [m= 1 and] obtains a detailed pattern from the point which forms nontransparent layer 102B which can shade the energy line to be used enough, and the diffraction phenomena of light, it is desirable. For example, in the KrF excimer laser whose wavelength is 248nm, the thickness d of a nontransparent layer is 62nm, 186nm, and about 310nm. Even if it makes m large to **, in respect of cross protection, effectiveness is equivalent. Although the thickness from which sufficient nontransparent ability is obtained by the quality of the material and the precision of nontransparent layer 102B differs, the smaller one of m is good in the range in which sufficient nontransparent ability is obtained from the point of a manufacturing cost or production time.
[0055] Since the thickness with the same nontransparent layer also differs by membranous precision, i.e., the process of film attachment, as for the protection-from-light degree of an energy line, it is desirable to choose m according to a membrane formation process within limits which can form a desired pattern. Since there is possibility (it will be transparent) that sufficient nontransparent nature will not be obtained depending on the quality of the material when thickness is too thin, especially m= 3 is desirable.
[0056] Moreover, as for the reflection factor difference of the transparency section of a photo mask, and the nontransparent section, it is desirable that it is less than 20%. That is, in order to enlarge effectiveness which the reflected lights of the transparency section and the nontransparent section are made to interfere, and is negated, the difference of the reflection factor of the transparency section and the

nontransparent section is small, and a comparable thing is desirable.
[0057] As transparence base material 102A of a photo mask 102, be [what is necessary / just although an energy line is penetrated enough], it is desirable to consist of ingredients which are mainly concerned with a quartz. The ingredient which is mainly concerned with a quartz means the ingredient with which a quartz is contained 70% or more. Although quartz glass is comparatively expensive, since permeability is high, there is an advantage that an energy line with a short wavelength of 300nm or less which especially micro processing tends to carry out can be used, to the energy line of an ultraviolet region. When using the energy line of long wave length from this, it is good to use optical glass from the point of cost. Although any number of thickness of transparence base material 102A is good, in order for a deflection not to arise in a base material but to take out display flatness stably, about 1-20mm is usually desirable.
[0058] Moreover, as for the nontransparent layer of a photo mask, it is desirable that it is the cascade screen of a chromium layer and a chrome oxide layer. That is, since the reflection factor is very high at one side, that [chromium's] of a wrap is desirable [the reflection factor of the transparency section is about 5% in general in quartz glass etc., and] at chrome oxide of about 18% of reflection factors in the front face. There are few amounts in which the energy line which reflected the nontransparent section front face in respect of chrome oxide of about 18% of reflection factors, then a medium is again reflected in respect of a mask, and since the reflection factor difference with quartz glass is small, it is desirable.
[0059] As an example of the manufacturing method of the photo mask 102 of this invention, on mask base material 102A, such as a quartz, chromium is formed first and chrome oxide is formed on it. There are approaches, such as a spatter, vacuum evaporationo, and spreading, as the membrane formation approach of chromium. However, from a viewpoint of forming the precise film, a sputtering technique is desirable. Moreover, although technique with the same said of the membrane formation approach of chrome oxide is used, the approach of forming membranes, while making it react with oxygen, in order to oxidize chromium is also employable.
[0060] Subsequently, a resist is applied with a spin coat etc. on the cascade screen of chromium and chromic oxide, and it exposes to a desired pattern. After exposure, by etching and removing chromium and chromic oxide according to the pattern, nontransparent layer 102B can be formed and a photo mask can be obtained.
[0061] In addition, the thickness of each film of nontransparent layer 102B formed by the cascade screen of chromium and chrome oxide As opposed to the thickness d of the cascade screen of the nontransparent layer which generally fills the above-mentioned formula although what is necessary is just extent from which the thickness d of the cascade screen of nontransparent layer 102B fills the above-mentioned formula, and the reflection factor of sufficient nontransparent nature and a request is obtained It is desirable that the thickness of the chromium film is [the thickness of 50 - 90% (namely, dx0.5-0.9) and the chrome oxide film] 10 - 50% (namely, dx0.1-0.5) of range.
[0062] Thus, heights according [the photo mask 102 in which nontransparent layer 102B was formed] to this nontransparent layer 102B were formed. This photo mask 102 is arranged so that the forming face of the nontransparent layer B may meet a magnetic disk 101.
[0063] In case a magnetization pattern is formed using such a photo mask, as for a photo mask 102, it is desirable that the distance between the magnetic-recording media 101 (the tooth space S of drawing 1 (a)) maintains a gap 1mm or less, and is arranged. If this gap is larger than this, the diffraction of an energy line will be large and a magnetization pattern will tend to fade.
[0064] However, a certain thing is desirable, the magnetic-recording medium 101 twisted for dust etc. to put by this and a mask 102 get damaged, and, as for the gap between a photo mask 102 and the magnetic-recording medium 101, 0.1 micrometers or more of defective generating can be suppressed. That is, when spacing is set to less than 0.1 micrometers, there is a possibility of the contact which a magnetization pattern formation part does not expect to be a photo mask 102 being caused, and damaging a photo mask 102 or the magnetic-recording medium 101 with the wave of the front face of the magnetic-recording medium 101. Moreover, since the thermal conductivity of a medium changes in a contact part, it is magnetized only there, and easy changes specifically and there is a possibility that it cannot draw as a desired pattern. Moreover, especially when the lubricating layer is prepared in the magnetic-recording medium 101 before magnetization pattern formation, in order to prevent that this lubricant adheres to a photo mask 102, it is desirable to prepare a gap 0.1 micrometers or more between a photo mask 102 and the magnetic-recording medium 101. This gap is more preferably set to 0.2 micrometers or more.
[0065] Although a spacer 122 may be inserted in locations other than a magnetization pattern formation field between both as both are shown in drawing 1 (a) that what is necessary is just the approach of maintaining at fixed distance as an approach of maintaining the gap of the magnetization pattern formation field of the magnetic-recording medium 101, and a photo mask 102, in support of a photo mask and a magnetic-recording medium, fixed distance may be maintained with specific equipment. Moreover, a spacer may be formed in the photo mask itself in one. Especially, when a spacer is formed in the periphery section or/and the inner circumference section of a magnetization pattern formation field of a medium between a photo mask and a magnetic-recording medium, since the effectiveness which corrects the wave of the front face of a magnetic-recording medium is born, the precision of magnetization pattern formation can be gone up, and it is desirable.
[0066] The hard thing of the quality of the material of a spacer 102 is good, and what is not magnetized since an external magnetic field is used for pattern formation is good. Preferably, they are metals, such as stainless steel and copper, and resin, such as polyimide. That what is necessary is just to be able to form the predetermined gap S between a photo mask 102 and the magnetic-recording medium 101, although the height of this spacer 102 is set as arbitration, it is usually several micrometers - hundreds of micrometers.
[0067] in addition, this invention -- setting -- the voice of the combination of partial heating and external magnetic field impression -- an external magnetic field is impressed like the above-mentioned, although it thinks like [various], after magnetizing the magnetic layer of the magnetic-recording medium 101 to homogeneity towards a beforehand request, preferably, an external magnetic field is impressed, it is magnetized to hard flow and the direction of this request of a heating unit forms a magnetization pattern at the same time it heats the magnetic-recording medium 101 locally. According to this approach, since the magnetic domain of the reverse sense is formed clearly mutually, a magnetization pattern with good C/N and S/N with strong signal strength is obtained.
[0068] Next, the energy line in this invention is explained.
[0069] As for an energy line, it is more desirable than continuous irradiation to make it the shape of a pulse and to perform control of a heating part and control of whenever [stoving temperature]. Especially, use of the pulse laser light source is suitable. The pulse laser light source is [that laser with a high power cusp value can be irradiated very much in a short time, and are recording of heat cannot take place easily] very desirable compared with what oscillate laser intermittently in the shape of a pulse, and continuation laser was made intermittent with optics, such as an acoustooptics component (AO) and an electro-optics component (EO), and was pulse-ized.
[0070] When continuation laser is pulse-ized with an optic, within a pulse, the pulse width is covered and it has the almost same power.

On the other hand, in order that the pulse laser light source may accumulate energy by resonance for example, within the light source and may emit laser at once as a pulse, within the pulse, its power of the cusp is very large and it becomes small after that. In this invention, since it is desirable to heat for a short time rapidly and to make it quench after that very much, in order that contrast may form the high, high magnetization pattern of precision, use of the pulse laser light source is suitable.

[0071] It is the front face of a magnetic-recording medium in which a magnetization pattern is formed at the time of the exposure of a pulse-like energy line, and not irradiating, and in order that the one where a temperature gradient is larger may raise the contrast of a pattern or may raise recording density, it is desirable. Therefore, it is desirable to have below room temperature extent at the time of un-irradiating [of a pulse-like energy line]. In addition, a room temperature is about 25 degrees C.

[0072] As for the wavelength of the energy line to irradiate, it is desirable that it is 1100nm or less. In order that a diffraction operation may be small and resolution may go up that an energy line is 1100nm or less in short wavelength, it is easy to form a detailed magnetization pattern. The wavelength of an energy line is 600nm or less still more preferably. It is not only a high resolution, but with such short wavelength, since diffraction is small, the large spacing of the mask and magnetic disk by the gap can also be taken, it is easy to carry out handling, and the advantage of becoming easy to constitute magnetization pattern formation equipment is born. Moreover, as for the wavelength of an energy line, it is desirable that it is 150nm or more. Absorption of the synthetic quartz which this wavelength uses for the transparence base material of a photo mask in less than 150nm becomes large, and it is easy to become inadequate heating it. Especially, 350nm or more, then optical glass can also be used for the wavelength of an energy line as a transparence base material of a photo mask.

[0073] Specifically as an energy line, 2 double wave (532nm) of excimer laser (248nm) and the Q switched laser (1064nm) of YAG, a 3 time wave (355nm) or a 4 time wave (266nm), Ar laser (488nm, 514nm), ruby laser (694nm), etc. are mentioned.

[0074] As for the power per one pulse of a pulse-like energy line, it is desirable to consider as two or less 1000 mJ/cm. If bigger power than this is applied, with a pulse-like energy line, a magnetic-recording medium front face may receive damage, and may cause deformation. When the surface roughness Ra of a magnetic-recording medium is set to 3nm or more according to deformation of this magnetic-recording medium or a wave Wa becomes large at 5nm or more, a possibility of causing trouble is in transit of a surfacing mold / contact mold head.

[0075] The power per one pulse of a pulse-like energy line is two or less 500 mJ/cm more preferably, and is two or less 100 mJ/cm still more preferably. Even when a substrate with comparatively big thermal diffusion is used as a nonmagnetic substrate of a magnetic-recording medium as it is this field, it is easy to form the high magnetization pattern of resolution. Moreover, as for this power, it is desirable to consider as two or more 10 mJ/cm. If smaller than this, magnetic transfer cannot happen easily that it is hard to go up the temperature of a magnetic layer.

[0076] Moreover, when anxious [with an energy line] about damage on the magnetic layer of a magnetic-recording medium, a protective layer, and a lubricating layer, power of a pulse-like energy line can be made small and means to raise the magnetic field strength impressed to this pulse-like energy line and coincidence can also be taken. For example, in the case of the record medium within a field, in the case of vertical recording, 1 - 50% of the biggest possible force is applied, and it is made to lower exposure energy 25 to 75% of the coercive force in ordinary temperature.

[0077] In addition, in irradiating a pulse-like energy line through a protective layer and a lubricating layer, the damage (decomposition, polymerization) which lubricant receives may be taken into consideration, and there may be the need for re-applying this after an exposure etc.

[0078] As for the pulse width of a pulse-like energy line, it is desirable that it is below 1microsec. If pulse width is wider than this, generation of heat by the energy given to the magnetic disk with the pulse-like energy line will distribute, and resolution will tend to fall. When the power per one pulse is the same, it is in the inclination for the resolution of a magnetization pattern to become high having shortened pulse width, and thermal diffusion being [direction] small and having irradiated powerful energy at once. The pulse width of a pulse-like energy line is 100 or less ns more preferably. Even when the substrate with comparatively big thermal diffusion which becomes being this field from metals, such as aluminum, as a nonmagnetic substrate of a magnetic-recording medium is used, it is easy to form the high magnetization pattern of resolution. In case a magnetization pattern with a minimum width of face of 2 micrometers or less is formed especially, as for the pulse width of a pulse-like energy line, it is desirable to be referred to as 25 or less ns. Namely, if resolution is thought as important, pulse width is so good that it is short. Moreover, as for pulse width, it is desirable that it is 1ns or more. This is because it is desirable to hold time amount until the flux reversal of the magnetic layer of a magnetic-recording medium is completed, and heating.

[0079] In addition, there is laser which can generate the ultrashort pulse of a picosecond and femtosecond level in a RF like a mode locked laser as a kind of a pulse-like energy line. In the period which is irradiating the ultrashort pulse by the RF, although laser is not irradiated to the very short time amount between each ultrashort pulses, since it is very short time amount, most heating units are not cooled. That is, the field by which the temperature up was once carried out more than Curie temperature is maintained more than Curie temperature. Therefore, in such a case, let a continuous irradiation period (continuous irradiation period also including the time amount by which the laser between ultrashort pulses is not irradiated) be one pulse. Moreover, let the integral value of the amount of exposure energy of a continuous irradiation period be the power per one pulse (mJ/cm2).

[0080] Moreover, in this invention, the intensity distribution of the energy line in an energy exposure field are preferably made into less than 15%. Thus, by pressing down intensity distribution, distribution of the heating condition of the field which irradiated the energy line can be suppressed small, and distribution of the magnetic strength of a magnetization pattern can be suppressed small. Therefore, in case signal strength is read using the magnetic head, the homogeneous high magnetization pattern of signal strength can be formed.

[0081] Generally energy lines, such as laser, have intensity distribution (energy density distribution) within the beam spot, and also when an energy line is irradiated and carries out local heating, the difference in the temperature rise by energy density produces them. For this reason, the difference in the reinforcement of an imprint takes place locally by heating nonuniformity. Usually, when pulse lasers, such as excimer laser and YAG-Q switch laser, are used, the intensity distribution in the beam spot are very large.

[0082] Then, in this invention, it is desirable to, perform equalization processing of the intensity distribution of an energy line for example, using the small energy line source of intensity distribution, and to suppress the intensity distribution within the beam spot of an energy line within 15%.

[0083] It equalizes, for example, using a homogenizer and a condensing lens as equalization processing of the intensity distribution of an energy line, or only the small part of the intensity distribution of an energy line is penetrated to a gobo, a slit, etc., and the approach of

expanding if needed is mentioned. When equalization processing is carried out by piling it up preferably once carrying out optical resolution of the energy line, an energy line can be used without futility and it is efficient. In this invention, it is good for heating of a magnetic layer to irradiate the energy line of high intensity for a short time, and it is desirable to it for that to use an energy line efficiently without futility.

[0084] in addition, although there are some by which the magnetic layer is formed in main both sides of a substrate in a magnetic-recording medium, in that case, you may carry out by the ability being alike serially, and the magnetization pattern formation of this invention can install every [one side] and a means to impress a mask, energy illuminating system, and an external magnetic field in both sides of a magnetic-recording medium, and can also perform magnetization pattern formation to double-sided coincidence.

[0085] The magnetic layer more than a bilayer is formed in the whole surface, by doubling the focus of the energy line to irradiate with each class, each class is heated according to an individual and the pattern according to individual can be formed to form a pattern which is different in each.

[0086] In case a magnetization pattern is formed, it is desirable to form an energy line for the gobo which can shade in the field which does not want to carry out the exposure between the light source of an energy line and a photo mask or between a photo mask and a magnetic-recording medium partially, and to consider as the structure which prevents the re-exposure of an energy line.

[0087] What is necessary is just to reflect or absorb an energy line that what is necessary is just what does not penetrate the wavelength of the energy line to be used as a gobo. However, since it will heat if an energy line is absorbed, and it is easy to affect a magnetization pattern, the high thing of a reflection factor which has good thermal conductivity is desirable. As such a gobo, metal plates, such as Cr, aluminum, and Fe, are used, for example.

[0088] Next, an external magnetic field is explained.

[0089] When a magnetic-recording medium is a disk type-like magnetic disk, as for the impression direction of an external magnetic field, it is desirable to take either of vertical to a hoop direction, radial, and a plate surface.

[0090] When impressing an external magnetic field to heating and coincidence, two or more magnetization patterns can be formed at once by continuing and impressing an external magnetic field to the this heated large field.

[0091] The magnetic head may be used for a means to impress an external magnetic field to the magnetic layer of a magnetic-recording medium, and more than one may be arranged and it may be used for it so that a field may produce an electromagnet or a permanent magnet in the desired magnetization direction. Furthermore, you may use it combining those different means. In order to magnetize efficiently the high coercive force medium suitable for high density record, permanent magnets, such as a ferrite magnet, a neodymium system rare earth magnet, and a samarium cobalt system rare earth magnet, are suitable.

[0092] Using the photo mask of this invention, the effect of an interference fringe is suppressed and, as for the magnetic-recording medium by which the magnetization pattern was formed according to this invention approach, is formed with a precision sufficient [the small detailed magnetization pattern of the modulation of a regenerative signal]. And magnetization transition width of face is small, magnetization transition on the boundary of a magnetic domain is very steep, and a pattern with the high quality of an output signal is formed. Moreover, in order to be able to form a magnetization pattern simple and not to make it stick with a master disc like before in a formation process for a short time very much moreover, there are few the blemishes and defects of a magnetic disk.

[0093] Since it is not only hard to write a servo signal, but servo record becomes the cause of main of a cost rise, when this invention is applied to the medium for high density record, effectiveness is large as it becomes high density record especially. If it is a vertical-magnetic-recording medium, since impression of a field is easy, it is easy to apply this invention.

[0094] therefore, the medium by which the highly precise magnetization pattern for head control was formed when including this technique in the production line of a magnetic-recording medium -- a short time -- and it can manufacture cheaply.

[0095] Next, the configuration of the magnetic-recording medium of this invention is explained.

[0096] As a nonmagnetic substrate in the magnetic-recording medium of this invention, even if it carries out high-speed rotation at the time of high-speed record playback, it is not necessary to vibrate, and a hard substrate is usually used. In order to acquire sufficient rigidity not vibrating, generally substrate thickness has 0.3 desirablemm or more. However, when the thickness of a substrate is too thick, since it is disadvantageous for thin-shape-izing of a magnetic recording medium, 3mm or less is desirable. As the quality of the material of a substrate, the alloy which used aluminum as the principal component, aluminum alloy substrates, such as an aluminum-Mg alloy, and the alloy which used Mg as the principal component, the substrate which specifically consists of Mg alloy substrates, such as a Mg-Zn alloy, other usual soda glass, aluminosilicate system glass, amorphous glass, silicon, titanium, ceramics, or various resin, the substrate which combined them can specifically be used, for example. It is desirable to use the substrate made of resin in respect of glass substrates, such as glass ceramics, and cost in respect of aluminum alloy substrate and reinforcement especially.

[0097] Like the above-mentioned, this invention is effective in especially the magnetic-recording medium that has a hard substrate. That is, the boundary of the magnetic domain which, as for the medium which has a hard substrate by the conventional magnetic-transfer method, adhesion with a master disc became inadequate, and the blemish and the defect occurred or was imprinted is indefinite, and although there were breadth and a cone inclination, since half-value width does not stick a photo mask and a magnetic-recording medium by pressure in this invention, such a problem is solved. Especially this invention is effective for the medium which has the substrate into which a crack tends to go like a glass substrate.

[0098] In the production process of a magnetic-recording medium, usually washing of a substrate and desiccation are performed first, and in order to secure the adhesion of each class also in this invention, it is desirable to perform washing of a substrate and desiccation before the formation.

[0099] Moreover, metal coat layers, such as NiP, may be formed in a substrate front face on the occasion of manufacture of the magnetic-recording medium of this invention. When forming such a metal coat layer, as the technique, the approach used for thin film formation of a nonelectrolytic plating method, the sputtering method, a vacuum deposition method, a CVD method, etc. can be used. If it is the case of the substrate which consists of a conductive ingredient, it is possible to adopt the electrolysis galvanizing method. Although there should just be 50nm or more of thickness of a metal coat layer, when the productivity of a magnetic-recording medium etc. is taken into consideration, it is especially desirable that it is 50-300nm 50-500nm.

[0100] Although the field which forms such a metal coat layer has the desirable substrate surface whole region, only the field where only a part gives the below-mentioned texture ring can be carried out.

[0101] Moreover, a concentric texture ring may be given to a substrate front face or the substrate front face in which the metal coat layer was formed. In addition, in this invention, the designation of the condition of having formed many minute slots in the substrate

circumferencial direction is carried out to this concentric texture ring by grinding to a circumferencial direction by using together texture ring processing using the mechanical texture ring which used the loose grain and the texture tape, a laser beam, etc., or these.
[0102] Here, as a class of loose grain for giving a mechanical texture ring, a diamond abrasive grain and the thing by which the front face is graphite--ization-processed especially are the most desirable. Although the alumina abrasive grain is widely used for others as an abrasive grain used for a mechanical texture ring, if it thinks from a viewpoint of the orientation medium within a field of carrying out orientation of the easy axis especially along a texture ring groove, a diamond abrasive grain will demonstrate the very good engine performance.
[0103] Since it is effective in implementation of high density magnetic recording that the front face of a substrate has the as much as possible small head flying height although surface roughness (Ra) is fundamentally [very] uninfluential in the effectiveness of this invention in what kind of value, as for especially Ra on the front face of a substrate, it is desirable that it is 1nm or less 2nm or less, and it is desirable that it is 0.5nm or less especially. In addition, the substrate surface roughness Ra uses a sensing-pin type surface roughness meter, and is after measurement and JIS in 400 micrometers of measurement length. It is the value-computed in conformity with B0601. At this time, as for the tip of the needle for measurement, the thing of magnitude with a radius of about 0.2 micrometers is used.
[0104] Although a magnetic layer (magnetic-recording layer) is formed on the substrate which gave formation of a metal coat layer, and a concentric texture ring like **** washing, desiccation, and if needed, a substrate layer may be prepared in advance of formation of this magnetic layer. What is formed for the purpose of controlling detailed-izing and the orientation of the crystal face of a crystal, and uses Cr as a principal component as the component is suitable for a substrate layer.
[0105] pure as an ingredient of the substrate layer which uses Cr as a principal component -- it is the purposes, such as crystal matching with a magnetic layer besides Cr, and an alloy, Oxidation Cr, etc. which added 1 or two or more elements which are chosen as Cr from V, Ti, Mo, Zr, Hf, Ta, W, germanium, Nb, Si, Cu, and B are mentioned.
[0106] The alloy which added 1 or two or more elements which are chosen as pure Cr or Cr from Ti, Mo, W, V, Ta, Si, Nb, Zr, and Hf especially is desirable. Although the optimal amount changes with each elements, generally, the content of these second and third elements has desirable 1 - 50 atom %, and is the range of 5 - 20 atom % preferably [it is more desirable and] to five to 30 atom %, and a pan.
[0107] That what is necessary is just fully [when forming a substrate layer] for that thickness making this anisotropy discover, when it is usual, 0.3-30nm 0.1-50nm is 0.5-10nm still more preferably preferably. At the time of membrane formation of the substrate layer which uses Cr as a principal component, even if it performs substrate heating, it is not necessary to carry out.
[0108] On a substrate layer, a soft magnetism layer may be prepared by the case between magnetic layers. Especially, such a soft magnetism layer has large effectiveness to a keeper medium with few magnetization transition noises, or the vertical recording medium which has a magnetic domain perpendicularly to the inside of the field of a medium, and is suitably used for it.
[0109] Although the component of a soft magnetism layer is comparatively high and there should be just little permeability as for loss, NiFe and the alloy which added Mo etc. as the 3rd element to it are used suitably. Although the optimal permeability changes a lot also with the property of the head used for record of data, or a magnetic layer, it is desirable that the maximum permeability is ten to 1 million (H/m) extent generally.
[0110] Or a CoCr system interlayer may be prepared on Cr substrate layer again.
[0111] Next, although a magnetic layer is formed, between the magnetic layer and the soft magnetism layer, the layer or other non-magnetic materials of the same ingredient as a substrate layer may be inserted. At the time of membrane formation of a magnetic layer, even if it performs substrate heating, it is not necessary to carry out.
[0112] As a magnetic layer, the cascade screen of Co alloy magnetic layer, the rare earth system magnetic layer which makes TbFeCo representation, and the transition metals which make the cascade screen of Co and Pd representation and a noble-metals system etc. is used preferably.
[0113] As a Co alloy magnetic layer, Co alloy magnetic material generally used as magnetic materials, such as pure Co, CoNi, CoSm, CoCrTa, CoNiCr, and CoCrPt, is usually used. What added elements, such as nickel, Cr, Pt, Ta, W, and B, and the compound of SiO2 grade to these Co alloys further may be used. For example, CoCrPtTa, CoCrPtB, CoNiPt, CoNiCrPtB, etc. are mentioned. Although the thickness of Co alloy magnetic layer is arbitrary, 5nm or more is 10nm or more more preferably. Moreover, 50nm or less is 30nm or less more preferably. Moreover, through a suitable nonmagnetic interlayer, directly, the laminating of this magnetic layer may be carried out more than two-layer, and it may be formed. Under the present circumstances, even if the presentation of a magnetic material by which a laminating is carried out is the same, they may differ.
[0114] The general thing as a magnetic material can be used as a rare earth system magnetic layer. For example, TbFeCo, GdFeCo, DyFeCo, TbFe, etc. are mentioned. Tb, Dy, Ho, etc. may be added to these rare earth alloys. Ti, aluminum, and Pt may be added from the purpose of oxidation degradation prevention. Although the thickness of a rare earth system magnetic layer is arbitrary, it is usually about 5-100nm. Moreover, through a suitable nonmagnetic interlayer, directly, the laminating of this magnetic layer may be carried out more than two-layer, and it may be formed. In that case, even if the presentation of a magnetic material by which a laminating is carried out is the same, they may differ. Especially a rare earth system magnetic layer is the amorphous structure film, and since it has magnetization perpendicularly to the inside of a media side, it is suitable for quantity recording density record, and high density and the approach of this invention which can form a magnetization pattern with high precision can apply it more effectively.
[0115] Although the general thing as a magnetic material can be used as a cascade screen of the transition metals and the noble-metals system which can perform a vertical magnetic recording similarly, Co/Pd, Co/Pt, Fe/Pt, Fe/Au, Fe/Ag, etc. are mentioned, for example. The transition metals of these cascade screen ingredients and noble metals may not be especially pure, and may be alloys which are mainly concerned with them. Although the thickness of a cascade screen is arbitrary, it is usually about 5-1000nm. Moreover, you may be the laminating of three or more sorts of ingredients if needed.
[0116] In this invention, the magnetic layer as a magnetic-recording layer is magnetized by holding magnetization in a room temperature, and it being demagnetized at the time of heating, or an external magnetic field being impressed by heating and coincidence.
[0117] In a room temperature, magnetization is held and the coercive force in the room temperature of this magnetic layer needs to be magnetized by homogeneity by the suitable external magnetic field. The medium which could hold the small magnetic domain and fitted high density record by setting coercive force in the room temperature of a magnetic layer to 2000 or more Oes is obtained. The coercive force in the room temperature of a magnetic layer is 3000 or more Oes more preferably.
[0118] Although the imprint was difficult for the magnetic-recording medium with too high coercive force like the above-mentioned, in

order to heat a magnetic layer in this invention, to fully lower coercive force and to form a magnetization pattern by the conventional magnetic-transfer method, application to the large magnetic-recording medium of coercive force is also effective.
[0119] However, coercive force in the room temperature of a magnetic layer is preferably set to 20 or less kOes. If this coercive force exceeds 20kOe(s), the big external magnetic field for package magnetization may be needed, and the usual magnetic recording may become difficult.
[0120] It needs to be magnetized by the weak external magnetic field by whenever [suitable stoving temperature], a magnetic layer holding magnetization in a room temperature. Moreover, the one where the difference of a room temperature and magnetization disappearance temperature is larger tends to form the magnetic domain of a magnetization pattern clearly. For this reason, the higher one of magnetization disappearance temperature is desirable, it is desirable, and is 150 degrees C or more more preferably. [of 100 degrees C or more] The existing magnetization disappearance temperature is desirable near the compensation temperature for example, near the Curie temperature (a little under Curie temperature).
[0121] Curie temperature is 100 degrees C or more preferably. At less than 100 degrees C, there is an inclination for the stability of the magnetic domain in a room temperature to be low. They are 150 degrees C or more and 700 degrees C or less more preferably. If a magnetic layer is heated too much in the upper limit of this temperature at an elevated temperature, it will be because it may deform.
[0122] When a magnetic-recording medium is a magnetic-recording medium within a field, to a magnetic-recording medium with the high coercive force for high density, by the conventional magnetic-transfer method, saturation record will be difficult, the high magnetization pattern generation of magnetic field strength will become difficult, and half-value width will also spread. According to this approach, also with the record medium within a field suitable for such high recording density, good magnetization pattern formation becomes possible. Especially when the saturation magnetization of this magnetic layer is especially 100 emu(s)/more than cc 50 emu(s)/more than cc, since the effect of an anti-field is large, the effectiveness which applies this invention is large. However, since formation of a magnetization pattern cannot carry out saturation magnetization easily if it is too large, 500 emu/its less than cc is desirable.
[0123] A magnetic-recording medium is a vertical-magnetic-recording medium, and since saturation magnetization becomes large and flux reversal tends to happen in a magnetic demagnetization operation when [that a magnetization pattern is comparatively large] the unit volume of one magnetic domain is large, it serves as a noise and worsens half-value width. This problem can be solved by concomitant use of the substrate layer which used soft magnetic materials, and the good record of it is attained also at these media.
[0124] A magnetic layer may be prepared more than a bilayer for storage capacity increase etc. Under the present circumstances, it is desirable to make other layers intervene between layers.
[0125] By usually forming a protective layer on the magnetic layer of a magnetic-recording medium, the maximum front face of a magnetic-recording medium is covered by the hard protective layer. A protective layer serves to prevent damage on the magnetic layer with masks, such as a head, a collision, and dust, dust, depended for putting. Moreover, in case the magnetization pattern formation method using a photo mask is applied like this invention, the operation from which a magnetic-recording medium is protected from contact to a photo mask is also done so.
[0126] Moreover, in this invention, the protective layer is indispensable also in the point of preventing oxidation of the heated magnetic layer. That is, generally it oxidizes, it is [a magnetic layer] easy, and if heated, it will tend [further] to oxidize. For this reason, in this invention, since a magnetic layer is locally heated with an energy line etc., it is necessary to form the protective layer for preventing oxidation beforehand on a magnetic layer.
[0127] What is necessary is just to prepare a protective layer on the magnetic layer near the maximum front face, when there is a two or more layers magnetic layer. A protective layer may be directly prepared on a magnetic layer, if needed, may make the layer which carries out other work intervene in between, and may be formed in it.
[0128] In this invention, a protective layer is also absorbed and a part of energy line irradiated with the formation process of a magnetization pattern serves to heat a magnetic layer locally by heat conduction. For this reason, since a magnetization pattern may fade by lateral heat conduction if a protective layer is too thick, the thinner one of the thickness of a protective layer is desirable. Moreover, also in order to make small distance of the magnetic layer at the time of record playback, and a head, the thinner one of a protective layer is desirable. Therefore, the thickness of a protective layer has desirable 50nm or less, and 30nm or less is 20nm or less still more preferably more preferably. However, in order to acquire sufficient endurance, the thickness of a protective layer has desirable 0.1nm or more, and it is 1nm or more more preferably.
[0129] Generally hard material, such as SiO2, Zr 2O3, and SiN, TiN, is used for formation of a protective layer. [carbonaceous layers, such as carbon, hydrogenation carbon, nitrogen-ized carbon amorphous carbon, and SiC and]
[0130] In a magnetic-recording medium, in order to bring the distance of a head and a magnetic layer close to a limit, it is desirable to prepare a very hard protective layer thinly. From the point of the effectiveness of it not only playing a shock-proof and lubricative point and the role of damage prevention of the magnetic layer by the energy line, but becoming very strong also to damage on the magnetic layer by the head, a carbonaceous protective layer is desirable and especially diamond-like carbon is desirable. The magnetization pattern formation approach of this invention is effectively applicable also to an opaque protective layer like a carbonaceous protective layer.
[0131] Such a protective layer may consist of layers more than two-layer.
[0132] When the layer which uses Cr as a principal component especially as a protective layer of the right above of a magnetic layer is prepared, the effectiveness which prevents the oxygen transparency to a magnetic layer is highly desirable.
[0133] On a protective layer, a lubricating layer is formed further, and the effectiveness which prevents damage by the photo mask and the magnetic head of a magnetic-recording medium by this is acquired. As lubricant used for a lubricating layer, fluorine system lubricant, hydrocarbon system lubricant, such mixture, etc. are mentioned, and it can apply with conventional methods, such as a dip method and a spin coat method. Since it does not become the hindrance of magnetization pattern formation, the thinner one of a lubricating layer is desirable, it is desirable that it is especially 4nm or less 10nm or less, but especially in order to obtain sufficient lubrication engine performance, it is desirable that it is 1nm or more 0.5nm or more.
[0134] When irradiating an energy line from on a lubricating layer, in consideration of the damage (decomposition, polymerization) of lubricant etc., re-spreading etc. may be performed after formation of a magnetization pattern like the above-mentioned.
[0135] As for the surface roughness Ra of the magnetic-recording medium after magnetization pattern formation, keeping at 3nm or less is desirable so that the transit stability of a surfacing mold / contact mold head may not be spoiled. In addition, the medium surface roughness Ra is the roughness on the front face of a medium which does not contain a lubricating layer, uses a sensing-pin type surface roughness meter, and is after measurement and JIS in 400 micrometers of measurement length. It is the value computed in conformity

with B0601. This medium surface roughness Ra may be 1.5nm or less more preferably.
[0136] Moreover, as for the surface waviness Wa of the magnetic-recording medium after magnetization pattern formation, keeping at 5nm or less is desirable. The medium external waviness Wa is a wave on the front face of a medium which does not contain a lubricating layer, and is the value computed after measurement according to Ra calculation using the sensing-pin type surface roughness meter by 2mm of measurement length. This medium external waviness Wa is more preferably set to 3nm or less.
[0137] Although it is arbitrary as the membrane formation approach which forms each class of the magnetic-recording medium of this invention, physical vapor deposition; such as the direct-current (magnetron) sputtering method, the RF (magnetron) sputtering method, the ECR sputtering method, and a vacuum deposition method, is mentioned, for example.
[0138] Moreover, what is necessary is for there to be especially no limit also as conditions at the time of membrane formation, and just to determine suitably a ultimate vacuum, the method of substrate heating and substrate temperature, sputtering gas pressure, bias voltage, etc. according to the property of the magnetic-recording medium considered as membrane formation equipment or a request. For example, in the usual case, for a ultimate vacuum, generally in sputtering membrane formation, 6.7x10 - 4 or less Pa and substrate temperature are [1.3x10-1 to 26.6x10 to 1 Pa and the bias voltage of room temperature -400 degree C and sputtering gas pressure] 0--500V.
[0139] When heating a nonmagnetic substrate in membrane formation, heating may be performed before the substrate stratification, when the rate of heat absorption uses a low transparent substrate, in order to make the rate of heat absorption high, after forming the substrate layer which has the substrate layer or B-2 crystal structure which uses Cr as a principal component, a substrate may be heated, and a magnetic layer etc. may be formed in after an appropriate time.
[0140] In the case of the magnetic film of a rare earth system, a magnetic layer carries out the mask of the most-inner-circumference section and the outermost periphery of a disk beforehand from the standpoint of corrosion and antioxidizing. The approach of carrying out laminating membrane formation to a magnetic layer, removing a mask in the case of membrane formation of the continuing protective layer, and covering a magnetic layer completely by the protective layer, and when a protective layer is two-layer If a mask is removed and a magnetic layer is too covered completely by the 2nd protective layer in case membranes are formed with the mask even of a magnetic layer and the 1st protective layer carried out and the 2nd protective layer is formed, the corrosion of a rare earth system magnetic layer and oxidation can be prevented, and it is suitable.
[0141] Next, the magnetic recording medium of this invention is explained.
[0142] The magnetic recording medium of this invention has the magnetic-recording medium which formed the magnetization pattern by the above-mentioned approach, the mechanical component which drives a magnetic-recording medium in the record direction, the magnetic head which consists of the Records Department and the playback section, a means to make the magnetic head displaced relatively to a magnetic-recording medium, and a record regenerative-signal processing means for performing the record signal input to the magnetic head, and the regenerative-signal output from the magnetic head. As the magnetic head, in order to perform high density record, a surfacing mold / contact mold magnetic head is usually used.
[0143] Since the magnetic-recording medium by which magnetization patterns, such as a highly precise servo pattern, were formed is used, high density record is possible for such a magnetic recording medium. Moreover, there is no blemish in a medium, and since there are also few defects, little record of an error can be performed.
[0144] Moreover, after building a magnetic-recording medium into equipment, the above-mentioned magnetization pattern can be reproduced by the magnetic head, a signal can be acquired, and a simply precise servo signal can be obtained by using a servo burst signal for the magnetic recording medium which it comes to record by this magnetic head on the basis of this signal.
[0145] Moreover, since it is easy to make it return to a desired location if the signal recorded as a magnetization pattern by this invention remains in the field which is not used as a user data area also after servo burst signal recording by the magnetic head also when a location gap of the magnetic head occurs according to a certain disturbance, the magnetic recording medium with which the signal by the approach to write both in exists is reliable.
[0146] A magnetic disk drive typical as a magnetic recording medium is illustrated, and it explains below.
[0147] The shaft to which a magnetic disk drive usually fixes one sheet or two or more sheets for a magnetic disk in the shape of food on a skewer, The motor made to rotate the magnetic disk joined to this shaft through bearing, It consists of the magnetic head used for record and/or playback, an arm in which this head was attached, and an actuator which can be made to move a head to the location of the arbitration on a magnetic-recording medium through a head arm, and the head for record playback is moving by the fixed flying height in the magnetic-disk top. Recording information is changed into a record signal through a signal-processing means, and is recorded by the magnetic head. Moreover, inverse transformation of the regenerative signal read by the magnetic head is carried out through this signal-processing means, and playback information is acquired.
[0148] On a magnetic disk, an information signal is recorded per sector along a concentric circular truck. A servo pattern is usually recorded between sectors. The magnetic head reads a servo signal in this pattern, carries out tracking to the core of a truck correctly by this, and reads the information signal of the sector. Tracking is similarly performed at the time of record.
[0149] High degree of accuracy is required on the property to use the servo pattern which generates a servo signal for the tracking at the time of recording information, as above-mentioned. Moreover, since the servo pattern used now consists of a pattern of 2 sets of 1 / 2 pitch ****** mutually around one truck, it is necessary to form it for one half of every pitches of an information signal, and a twice as many precision as this is required. [many]
[0150] However, by the conventional servo pattern formation approach, about 0.2-0.3 micrometers is a limitation in the light width of recording track under the effect of vibration produced from the centers of gravity of an external pin and an actuator differing, and the precision of a servo pattern does not catch up with the increment in track density, but it is becoming the hindrance of the improvement in recording density of a magnetic recording medium, and a cost cut.
[0151] on the other hand, since the efficient high magnetization pattern of precision can be formed by using a contraction image formation technique according to this invention, compared with the conventional servo pattern formation approach, it can be markedly alike, and a servo pattern can be formed with a sufficient precision in low cost and a short time, for example, the track density of a medium can be raised to 40 or more kTPIs. Therefore, the magnetic recording medium using this medium becomes recordable at high density.
[0152] Moreover, since the servo signal which changes continuously will be obtained if a phase servo system is used, track density can be raised more, the tracking below 0.1-micrometer width of face also becomes possible, and high density record is more possible.
[0153] As mentioned above, the magnetization pattern aslant prolonged from inner circumference linearly to a radius at a periphery is used for a phase servo system. Rotating a disk, from the conventional servo pattern formation approach which records one truck of servo

signals at a time, it was hard to make such a pattern which followed radial and a slanting pattern, and they needed complicated count and a complicated configuration by it.
[0154] on the other hand, the medium used for a phase servo system since according to this invention the pattern concerned can be easily formed only by irradiating an energy line through a mask once it creates the mask according to this configuration -- easy and a short time -- it can create cheaply. As a result, the magnetic recording medium of a phase servo system in which high density record is possible can be offered.
[0155] By the way, conventionally, after the mainstream servo pattern formation approach builds a magnetic-recording medium into a magnetic recording medium (drive), it is performed using the servo writer of dedication in a clean room.
[0156] That is, a servo writer is equipped with each drive, and it records one pattern at a time along a truck, inserting the pin of a servo writer and moving the magnetic head mechanically from the hole in either a drive front face or a rear face. For this reason, it takes time amount very much with about 15 - 20 minutes per drive. Moreover, in order to open a hole in a drive, using the servo writer of dedication, these activities needed to be done in the clean room, and the process top was also complicated and was the factor of a cost rise.
[0157] On the other hand, in this invention, a servo pattern or the reference pattern for servo pattern record can be collectively recorded by irradiating an energy line through the mask which recorded the pattern beforehand, and a servo pattern can be formed in a medium in very simple and a short time. Thus, the magnetic recording medium incorporating the medium in which the servo pattern was formed becomes unnecessary [the above-mentioned servo pattern write-in process]. Or the magnetic recording medium incorporating the medium in which the reference pattern for servo pattern record was formed can write in the servo pattern of a request within equipment based on this reference pattern, the above-mentioned servo writer is unnecessary and its activity in a clean room is also unnecessary. Moreover, it is not necessary to open a hole in the background of a magnetic recording medium, and is desirable also on endurance or safety.
[0158] Furthermore, since it is not necessary to stick between a photo mask and magnetic-recording media in this invention, damage on the medium of the damage, the minute dust, and dust by contact to a magnetic-recording medium and other configuration members twisted for putting can be prevented, and generating of a defect can be prevented.
[0159] As mentioned above, according to this invention, the magnetic recording medium in which high density record is possible can be cheaply obtained at a simple process.
[0160] In addition, as the magnetic head of the magnetic recording medium of this invention, various kinds of things, such as a thin film head, an MR head, a GMR head, and a TMR head, can be used. By constituting the playback section of the magnetic head from an MR head, sufficient signal strength can be obtained also in high recording density, and the magnetic recording medium of high recording density can be realized.
[0161] Moreover, if the flying height surfaces the magnetic head in 0.001 micrometers or more, less than 0.05 micrometers, and height lower than before, an output improves, high equipment S/N is obtained and a highly reliable magnetic recording medium can be offered with large capacity.
[0162] Moreover, sufficient S/N is obtained, also when it can improve recording density further, for example, will record and reproduce with the recording density beyond 3G bit per 13 or more kTPIs of track density, 250 or more kFCIs of track recording density, and 1 square inch, if the digital disposal circuit by the maximum likelihood decoding method is combined.
[0163] Two or more conductive magnetic layers which furthermore produce a big resistance change when the mutual magnetization direction changes the playback section of the magnetic head with external magnetic fields relatively, By considering as the GMR head which consists of a conductive non-magnetic layer arranged between the conductive magnetic layer, or the GMR head using the spin bulb effectiveness Signal strength can be raised further and it becomes realizable [a magnetic recording medium with the high dependability which had more than 10G bit and the track recording density of 350 or more kFCIs per 1 square inch].
[0164]
[Example] Although the example of a comparison and an example are given to below and this invention is more concretely explained to it, there is no this invention what is limited to the following examples, unless the range of the summary is exceeded.
[0165] The aluminium alloy substrate with NiP plating of the diameter of 13.5 inches of examples of a comparison (1.0mm in thickness) is washed. It dries. On it under conditions of ultimate-vacuum:1.3x10-5Pa, substrate temperature:350 degree C, bias voltage:-200V, sputtering gas:Ar, and gas pressure:4x10-1Pa NiAl -- 60nm in thickness -- Cr94Mo6 -- 10nm in thickness -- Co72Cr18Pt10 was carried out as a magnetic layer at 22nm in thickness, and sequential membrane formation of the carbon (diamond-like carbon) was carried out as a protective layer at 3nm in thickness.
[0166] The surface roughness Ra of this magnetic disk was 0.5nm, and the wave Wa was 0.8nm. On it, fluorine system lubricant was applied to the thickness of 1.5nm as a lubricating layer, it calcinated at 100 degrees C for 40 minutes, and coercive force 3000Oe in a room temperature and the magnetic disk for the record within [of 310 emu/cc saturation magnetization] a field were obtained. The Curie temperature of a magnetic layer was 250 degrees C.
[0167] It constituted on this disk so that the direction of a field of an electromagnet might become the same as the hand of cut of a disk, and it was impressed by it by the reinforcement of about 10 kG(s), and the disk side was magnetized uniformly.
[0168] In addition, in flux density, if B (unit: gauss) and a field are set to H (unit: oersted) and permeability is set to mu, the relation of B=mu-H will be realized. In air, since permeability is about 1, it is equal to having impressed the field of 10kOe as flux density is 10kG (s).
[0169] About 10-micrometer gap was opened on this disk, and Cr photo mask which used quartz glass as the base material has been arranged. This photo mask used the quartz glass of a 127mmx127mm square and 2.3mm thickness as the base material, etched chromium into the pattern which forms one by one by 25nm thickness, and is shown at drawing 2 for chromic oxide at 75nm in thickness, and formed the nontransparent section in the field side which counters a disk. In d= (mxlambda/4), m of the thickness of the nontransparent layer which consists of a cascade screen of this chromium and chrome oxide is about 1.6.
[0170] The formed etching pattern forms the pattern of a radial with a die length [as shown in drawing 2 (b) which is the enlarged drawing of the B section of drawing 2 (a)] of 10mm in the annular (the radius of 30mm of a circumferential circle, radius of 40mm of a periphery circle) etching field 2 which attached the dot of the quartz-glass substrate 1 of a 127mmx127mm square, as shown in drawing 2 (a). Like the periphery, pattern width of face becomes thick, and spacing of patterns also becomes large and, as for this pattern, 2 micrometers and pattern spacing with the largest spacing of a periphery have become [the pattern width of face of the thickest part of a periphery] 2 micrometers.
[0171] They were rotated at the rate of 1 rotation in 3.2 seconds, having used this photo mask and disk as one. An excimer pulse laser with

a wavelength of 248nm here Pulse width:25ns, Power (energy density) : Control to 120 mJ/cm2 and shape-of-beam:10mmx30mm (path used as 1 of peak energy / e2), and the gobo which operates the shape of beam orthopedically to laser radiation opening at a sector with an include angle of 12 degrees is installed. 32 pulse irradiation was carried out on the repeat frequency of 10Hz, the field of about 1.7 kG(s) was impressed to coincidence with the permanent magnet in the direction contrary to uniform magnetization by the circumferencial direction of a magnetic disk, and the imprint of a magnetic pattern was tried.
[0172] In addition, the configuration of the optical system for laser radiation used here is as follows.
[0173] The pulse laser oscillated from the excimer pulse laser light source passes a programmable shutter. A programmable shutter carries out the duty which takes out only a desired pulse from the light source.
[0174] The laser chosen by the programmable shutter is changed into desired power by the attenuator.
[0175] Subsequently, laser passes the homogenizer (fly eye lens) for trichotomizing the direction of a minor axis, and the homogenizer (fly eye lens) for dividing the direction of a major axis into seven, and results in a projection lens. A homogenizer (fly eye lens) has the function which divides laser and makes superposition and energy intensity distribution homogeneity. Furthermore, after it makes laser into the desired shape of beam through a gobo if needed and it changes intensity distribution according to a magnetization pattern with a photo mask, it is projected on a disk.
[0176] Thus, it confirmed by developing a magnetization pattern with a magnetic developer and observing the quality of a magnetization pattern with an optical microscope about the disk in which the magnetization pattern was formed.
[0177] Consequently, in this example 1 of a comparison, the interference fringe was observed and it was checked that the magnetization pattern is disturbed by this.
[0178] Moreover, it was 12%, when the magnetic pattern was reproduced by the MR head for hard disks with a playback component width of face of 0.9 micrometers and the modulation of the regenerative signal was measured, after completely forming a magnetization pattern on a magnetic disk on the same conditions.
[0179] A magnetic pattern is formed like the example 1 of a comparison except having used the photo mask which carried out chromium by 140nm and carried out sequential membrane formation of the chrome oxide by 46nm thickness as example 1 photo mask. In d= (mxlambda/4), m of the thickness of the nontransparent layer which consists of a cascade screen of this chromium and chrome oxide is about 3.
[0180] Thus, about the disk in which the magnetization pattern was formed, if it observes similarly with the example 1 of a comparison, formation of an interference fringe will not be seen.
[0181] Moreover, if a magnetic pattern is reproduced by the MR head for hard disks with a playback component width of face of 0.9 micrometers and the modulation of the regenerative signal is measured after completely forming a magnetization pattern on a magnetic disk on the same conditions, modulation will be improved and only the part whose interference fringe was lost will serve as a value which is about 8% from the magnetic disk of the example 1 of a comparison.
[0182]
[Effect of the Invention] According to the magnetization pattern formation approach and photo mask of a magnetic-recording medium of this invention, the following effectiveness is done so as explained in full detail above.
** Since partial heating and external magnetic field impression are combined in forming a magnetization pattern, it is not necessary to use a strong external magnetic field like before. And since it is not magnetized even if a field is impressed in addition to a heating field, magnetic-domain formation can be limited to a heating field. For this reason, a magnetic-domain boundary becomes clear, magnetization transition width of face is small, magnetization transition on the boundary of a magnetic domain is very steep, and a pattern with the high quality of an output signal can be formed. If conditions are chosen, it is also possible to set magnetization transition width of face to 1 micrometer or less.
** There is also no possibility of making the defect of a medium increasing, without damaging a medium and a mask, since it is not necessary to make a magnetic-recording medium and a master disc stick by pressure like before.
** A slanting magnetization pattern can also be formed good to a truck.
** Since an energy line is used for partial heating, it is easy to carry out the magnitude of a part and the control of power to heat, and a magnetization pattern can be formed with a sufficient precision.
** Once it produces a photo mask, the magnetization pattern of any configurations and the special pattern which was hard to make from a complicated pattern and a complicated conventional method since it formed on a magnetic-recording medium can be formed easily. Moreover, it can create simple [a photo mask] and cheaply.
** Since the reflection in respect of transparency of a photo mask and the reflection in respect of nontransparent become an opposite phase and erase inside by controlling the thickness of the nontransparent layer of a photo mask, the effect of reflective is mitigated, generation of an interference fringe is suppressed, and accurate magnetization pattern formation can be performed.
** The magnetic-recording medium which carried out magnetization formation using the photo mask of this invention has little effect of an interference fringe, the precision of a magnetization pattern is high and the modulation of the output signal of a magnetization pattern serves as a small good magnetic-recording medium.
** the magnetic-recording medium by which the highly precise magnetization pattern for head control was formed by including this technique in the production line of a magnetic-recording medium -- a short time -- and it can manufacture cheaply.
[0183] And as for the magnetic-recording medium of this invention in which the magnetization pattern was formed by this invention approach using the photo mask of this invention, the effect of an interference fringe was suppressed, and the small detailed magnetization pattern of the modulation of a regenerative signal was formed with a sufficient precision. And magnetization transition width of face is small, magnetization transition on the boundary of a magnetic domain is very steep, and a pattern with the high quality of an output signal is formed. Moreover, in order to be able to manufacture very simple in a short time and not to make it stick with a master disc like before, there are few blemishes and defects. Since it is not only hard to write a servo signal, but servo record becomes the cause of main of a cost rise as it becomes high density record especially, this invention is [as opposed to / especially / the magnetic-recording medium for high density record] effective.
[0184] Moreover, if it is the magnetic recording medium of this invention which has the magnetic-recording medium which formed the magnetization pattern by the magnetization pattern formation approach of such this invention, since the magnetic-recording medium by which magnetization patterns, such as a high-density servo pattern, were formed will be used, high density record is possible, and there is no blemish in a medium, and since there are also few defects, little record of an error can be performed.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 (a) is the typical sectional view showing the gestalt of the operation of the magnetization pattern formation approach which used the photo mask of this invention, and drawing 1 (b) is the typical perspective view showing the magnetization direction of a magnetic disk.
[Drawing 2] Drawing 2 (a) is the typical top view showing the etching pattern given to the photo mask in the example 1 of a comparison, and the example 1, and drawing 2 (b) is the enlarged drawing of the B section of drawing 2 (a).
[Description of Notations]
1 Quartz-Glass Substrate
2 Etching Field
101 Magnetic-Recording Medium (Magnetic Disk)
102 Photo Mask
103 Laser Beam
104 External Magnetic Field
120 Spindle
121 Turntable
122 Spacer
123 Pressure Plate

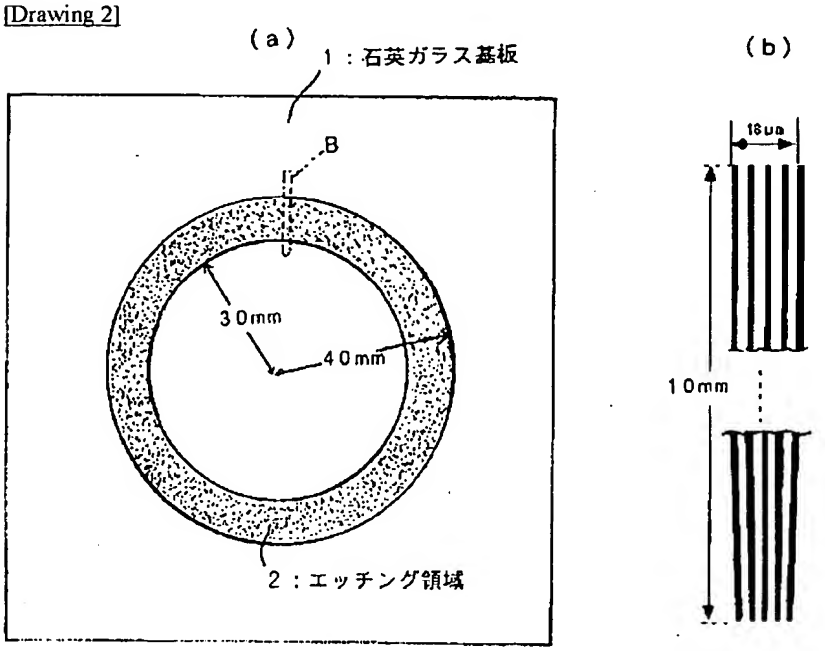
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

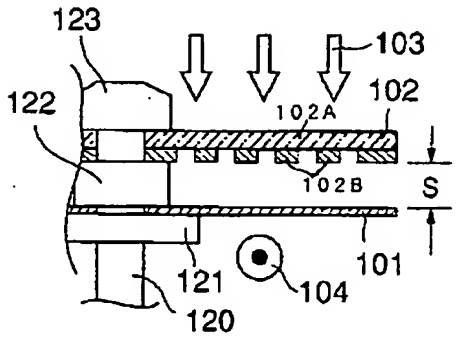
DRAWINGS

[Drawing 2]

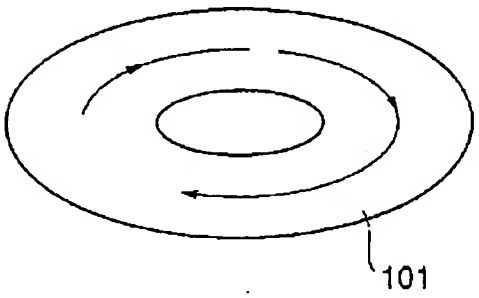


[Drawing 1]

(a)



(b)



[Translation done.]